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A new species of *Bathyacmaea* (Gastropoda: Pectinodontidae) from a methane seep area in the South China Sea

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ABSTRACT

Bathyacmaea lactea new species, collected from a methane seep area in the South China Sea, is described and illustrated, as the sixth species of the genus *Bathyacmaea* Okutani, Tsuchida and Fujikura, 1992. The generic assignment is primarily based on radula morphology, which has a formula of 0-1-0-1-0 and each lateral teeth consists of three cusps. The new species resembles *Bathyacmaea jonassoni* Beck, 1996, *Bathyacmaea tertia* Sasaki, Okutani, and Fujikura, 2003, and *Bathyacmaea secunda* Okutani, Fujikura and Sasaki, 1993 in having relatively smooth shell sculpture, but differs from those species by its much thicker shell, strongly chipped aperture margin forming denticle-like structures, and radular morphology.

Additional keywords: Patellogastropoda, Lottioidea, cold seep, radula

INTRODUCTION

The genus *Bathyacmaea* was established by Okutani, Tsuchida, and Fujikura (1992: 140) on the basis of single species, *Bathyacmaea nipponica*, off Hatsushima Islet, Japan. Since then, four species have been described by subsequent authors, *Bathyacmaea secunda* Okutani, Fujikura, and Sasaki (1993: 130, figs 13–19) from Minami Ensei Knoll and Iheya Ridge, Japan, *Bathyacmaea jonassoni* Beck (1996: 90, text-fig. 3, plate 2) from Edison Seamount, off Lihir Island, *Bathyacmaea subnipponica* Sasaki, Okutani, and Fujikura (2003: 193, fig. 6) from Ryuyo Canyon, Japan and *Bathyacmaea tertia* Sasaki, Okutani, and Fujikura (2003: 190, figs 3B, 4, 5) from North Knoll of Iheya Ridge, Japan. In addition, an unnamed species, *Bathyacmaea* sp., was also reported by Sasaki, Okutani, and Fujikura (2003: 195, fig. 7) from the Sumisu Caldera, Japan. Up to now, all known members of this genus are restricted to deep sea areas in the western Pacific.

Since the beginning of exploration of the benthic communities associated with hydrothermal vents, seeps, and seamounts carried out in the western Pacific, many interesting and new species of mollusks have been reported (Beck, 1992; Hasegawa, 1997; Hasegawa et al., 1997; Waren and Bouchet, 2001; Hasegawa, 2005; Sasaki et al., 2005, 2008). The investigations of hydrothermal vents and seeps by the Institute of Oceanology, Chinese Academy of Sciences (IOCAS) started in 2014, and during research dives by the submersible ROV Faxian in April of that year, five specimens of patelliform gastropod were collected from cold seep areas in the South China Sea. Observations of the shell and radular morphology reveal that they represent an undescribed species belonging to *Bathyacmaea*. In this paper, we describe and illustrate this species as new to science, and compare it with other congeners.

MATERIALS AND METHODS

A total of five specimens were collected during two dives of the ROV Faxian (IOCAS) in April, 2014 at a methane seep area in the South China Sea. The materials were fixed in 99.5% ethanol directly after collection. The shell and soft part were observed under light microscopy, and the radular structure under a scanning electron microscope (SEM).

For SEM studies, radular sacs were removed and placed in 10% NaOH solution for 4–5 hours. The radula was then dehydrated through an ethanol series and laid on a cover slip to air-dry. The samples were then coated with gold and examined under a Hitachi S-3400N scanning electron microscope. Type material s is deposited in the Marine Biological Museum, Chinese Academy of Sciences (MBMCAS), Qingdao, China.

SYSTEMATICS

Family Pectinodontidae Pilsbry, 1891

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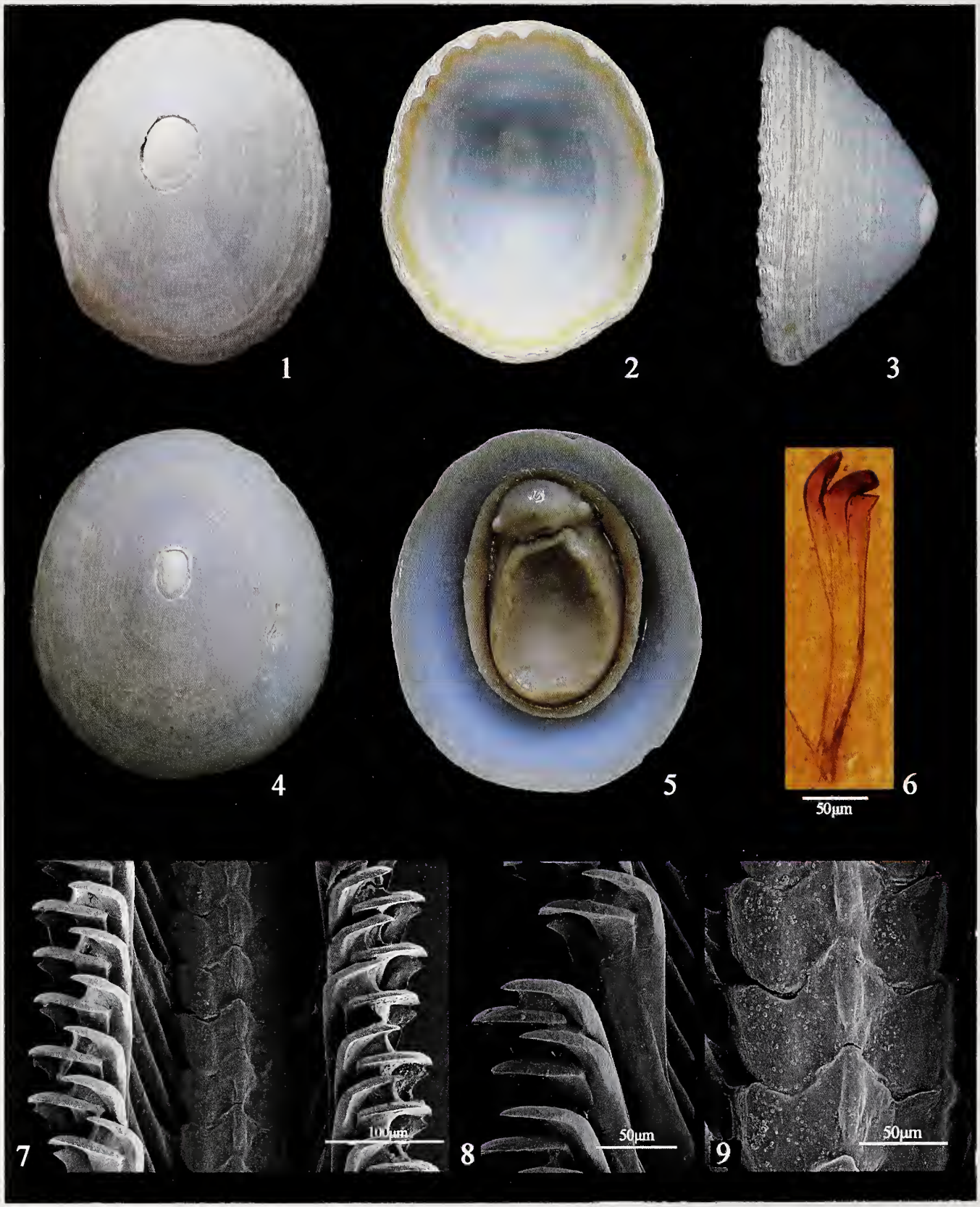

Figures 1–9. *Bathyacmaea lactea* new species. **1–3.** Dorsal, ventral, and lateral view of holotype. **4–5.** Dorsal and ventral view of paratype. **6–9.** Radula. **6.** Single lateral tooth under light microscopy. **7.** Dorsal view of intact radular segment. **8.** Enlargement of right lateral teeth. **9.** Basal plates representing rachidian teeth.

Genus *Bathyacmaea* Okutani, Tsuchida, and Fujikura, 1992

Type Species: *Bathyacmaea nipponica* Okutani, Tsuchida and Fujikura, 1992 (Hatsushima Islet, Japan).

***Bathyacmaea lactea* new species**
(Figures 1–9)

Diagnosis: Shell whitish, longitudinally elongated. Shell surface with relatively smooth sculpture consisting of dense growth lines and microscopic radial threads. Apertural margin strongly chipped, forming denticle-like structure. Radular formula 0-1-0-1-0. Lateral teeth trifurcated, with straight, stout shaft. All three cusps outwardly bent; innermost and middle cups sickle-shaped and subequal in size, outermost one smallest, with acute tip.

Description: Shell (Figures 1–5) patelliform, very thick (ca. 1.5 mm and ca. 1.2 mm above aperture margin in holotype and paratype, respectively), and solid, with oval outline, longer than wide, width about 82–87% of length, anterior end slightly narrower than posterior end. Profile high for genus, height about 43–49% of shell length. Apex situated at anterior 2/5 of shell length. Protoconch rounded and smooth. Anterior slope more or less straight and posterior slope slightly convex. External surface opaque white, sculptured with dense irregular growth lines and microscopic radial threads, the growth lines relatively thin near the apex but gradually stronger toward the apertural margin. Apertural margin strongly chipped, forming denticle-like structure in holotype but less prominent in paratype. Internal surface opaque whitish with exception of yellowish near apertural margin in holotype.

Animal (Figures 5, 10) with very short tentacles, eyes lacking. Head stout and rounded, without oral lappets. Ctenidium bipectinate and large. Intestine blackish due to dark-grey contents, stomach very large, C-shaped, situated in central position and partly covered by digestive gland. Intestine and stomach containing lumpish and spongy material. Gonad situated at posterior end of visceral mass. Urogenital papilla digitiform in shape, situated on right rear corner of ctenidium.

Radula (Figures 6–9) docoglossate with formula 0-1-0-1-0. Rachidian tooth represented by longitudinal, ridge-like strueture. Rachidian basal plate wider than long, mid-anterior edge and anterior outer corners markedly protruded. Lateral tooth trifurcated, and with straight, stout shaft. All three cusps outwardly bent, innermost and middle cusps sickle-shaped and subequal in size, outermost one smallest with an acute tip.

Type Locality: A methane seep area at 22°07′ N, 119°18′ E, in 1132.5 m depth, South China Sea.

Type Material: Holotype MBM283045 (length 18.5 mm, width 15.2 mm, height 9.1 mm), from type locality; Paratype MBM283046 (length 19.6 mm, width 17.0 mm, height 8.5 mm), 22°06′ N, 119°17′ E, in 1,132 m, methane seep area, South China Sea. Three additional immature specimens, one collected with holotype (type locality) and the other two with the paratype, were also observed. All collected by ROV Faxian (Mother-ship R/V Kexue, IOCAS), April, 2014.

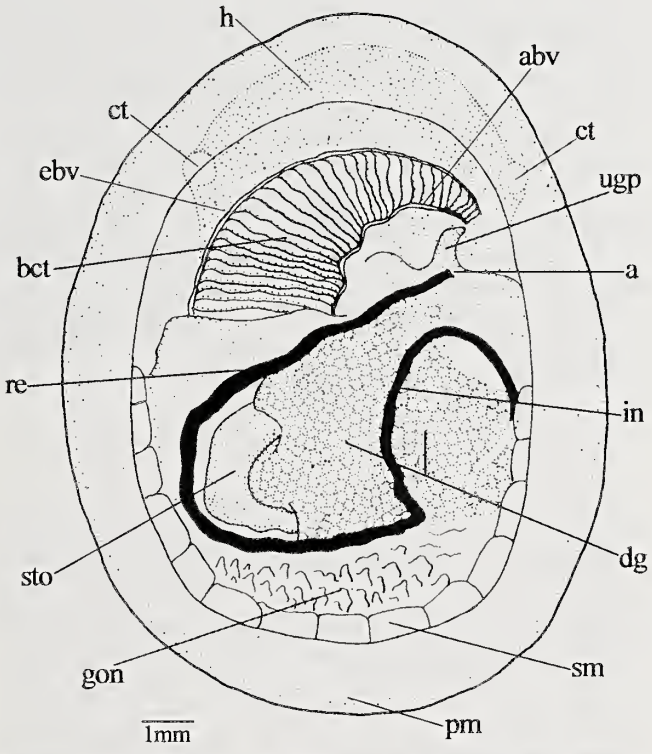

Figure 10. Paratype of *Bathyacmaea lactea* new species. Dorsal view, shell removed, head and cephalic tentaeles shown by transpareney. Abbreviations: **a,** anus; **abv,** afferent branchial vein; **bct,** bipectinate ctenidium; **ct,** cephalic tentacle; **dg,** digest gland; **ebv,** efferent branchial vein; **gon,** gonad; **h,** head; **in,** intestine; **pm,** pallial margin; **re,** rectum; **sm,** shell muscle; **sto,** stomach; **ugp,** urogenital papilla.

Etymology: Latin *lactea*, meaning milky white, a reference to the shell color of the new speeies.

Comparative Remarks: Members of *Bathyacmaea* are restricted to the western Pacific. Until now, five species have been reported. With exception of *Bathyacmaea jonassoni* Beck, 1996, found on a seamount, all other species were discovered within or near the chemoautosynthesis-based communities: *Bathyacmaea nipponica* and *Bathyacmaea subnipponica* from cold seeps, and *Bathyacmaea tertia* and *Bathyacmaea secunda* from hydrothermal vents.

Observations on shell and radula confirm that the new species belongs to the genus *Bathyacmaea*. Therefore, *Bathyacmaea lactea* new species represents the sixth recognized species of the genus. In shell characters, the new species differs from all congeners by its much thicker shell. *Bathyacmaea lactea* new species can be readily distinguished from *Bathyacmaea nipponica* and *Bathyacmaea subnipponica* in having relatively smooth rather than granulated or nodular shell sculpture. The new species resembles *Bathyacmaea jonassoni*,

Bathyacmaea tertia, and *Bathyacmaea secunda* in having relatively smooth shell sculpture. However, in *Bathyacmaea lactea*, the outermost cusp of lateral tooth is outward-bent, with pointed tip, whereas in *Bathyacmaea tertia* the outermost cusps of the lateral tooth are straight with a gently arched outer edge. *Bathyacmaea lactea* is different from *Bathyacmaea secunda* in having elongated rather than nearly circular shell, moderately high instead of low shell, much wider innermost cusp and much more slender outermost cusp of lateral teeth. *Bathyacmaea jonassoni* can be separated from the new species in having much more elongated and slender shafts of lateral teeth.

ACKNOWLEDGMENTS

This research was supported by the Strategic Priority Research Program of the Chinese Academy of Sciences (XDA11030201). We would like to express our sincere thanks to the crews of R/V Kexue for their cooperation during the survey. Thanks also to Dr. Lothar A. Beck for proving us important references.

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Recognition of *Biomphalaria* species (Gastropoda: Planorbidae) using the spiral growth variability, with description of a new fossil species

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ABSTRACT

The freshwater genus *Biomphalaria* Preston, 1910 is a well studied genus of freshwater snails, due to its importance as an intermediate host of the human parasite *Schistosoma mansoni* (Platyhelminthes). Soft parts are used to differentiate among modern species of *Biomphalaria*, but these parts are not present in fossils. The aim of this paper is to show another approach to discriminate among *Biompahalaria* species, by means of the analysis of the logarithmic spiral of the shell. We eompared five species, two modern and well known ones, *Biomphalaria peregrina* (d'Orbigny, 1835) and *Biomphalaria tenagophila* (d'Orbigny, 1835), a fossil one, *Biomphalaria walteri* (Parodiz, 1969), and two new fossil species. All fossils are from the Queguay Formation (Late Cretaeeous, Uruguay). The variance of the spiral was analized using a Kruskal-Wallis test with *a posteriori* Mann-Whitney pairwise comparisons. A morphological analysis had to be done to determine whether the specimens belong to different species. Our conclusions are that the analysis of the variance of the spiral coefficient can be used as a complementary character, but not as a primary method of differentiation between species. A new species is described as a result of the combined results of the statistical analysis and the traditional morphological description.

Additional Keywords: Late Cretaceous, logarithmic spiral, freshwater fossils

INTRODUCTION

Species of the freshwater gastropod *Biomphalaria* Preston, 1910 are distributed in the tropics and subtropics of the Americas and Africa (Taylor, 1988). Several species have medical importance because they are intermediate hosts of the human parasite *Schistosoma mansoni* (Platyhelminthes), whieh affects more than 200 million people in the world (WHO, 1985; Crompton et al., 1999; Chitsulo et al., 2000).

The shell in the genus is rather simple and not very informative taxonomically. Shell morphology of the genus, therefore, is used only as a secondary taxonomic criterion. Taxonomy of the genus is based on the anatomy, mainly the reproductive system (Paraense and Deslandes, 1959; Paraense, 1975, 1981, 1984, 1988; Luz et al., 1998), or even, and most recently, on molecular genetics, in particular DNA (Vidigal et al., 2000, 2004; Spatz et al., 1999; DeJong et al., 2001). A relatively recent review of the systematics of the genus can be found in Jarne et al. (2011).

Some authors did statistical analyses of some shell dimensions (height, width), or number and shape of the whorls, but this methodology gave only approximate results (Jarne et al., 2011). Identification of species based only on the shell morphology is a common problem in mollusks, in particular in gastropods, and non-traditional morphometric solutions has been tried. For example, to distinguish between species of *Physa*, Samadi et al. (2000) studied shells and anatomical characters of some populations. They estimated Raup's (1966) parameters and analysed the variance. Unfortunately, the landmarks required in this method cannot be obtained for a planispiral shell, consequently the procedure is not useful for *Biomphalaria*. Johnston et al. (1991) modeled the spiral growth using geometric morphometrics, but they used shells of the marine genus *Epitonium* that has a conispiral shell with axial varices along the shell, and they could use the varix-suture intersections as landmarks. Determination of landmarks requires homologous intersections of lines, necessarily constant and repeatable in all specimens (Bookstein, 1991; Park et al. 2013). Due to its simple, planispiral shell, *Biomphalaria* does not have such intersections.

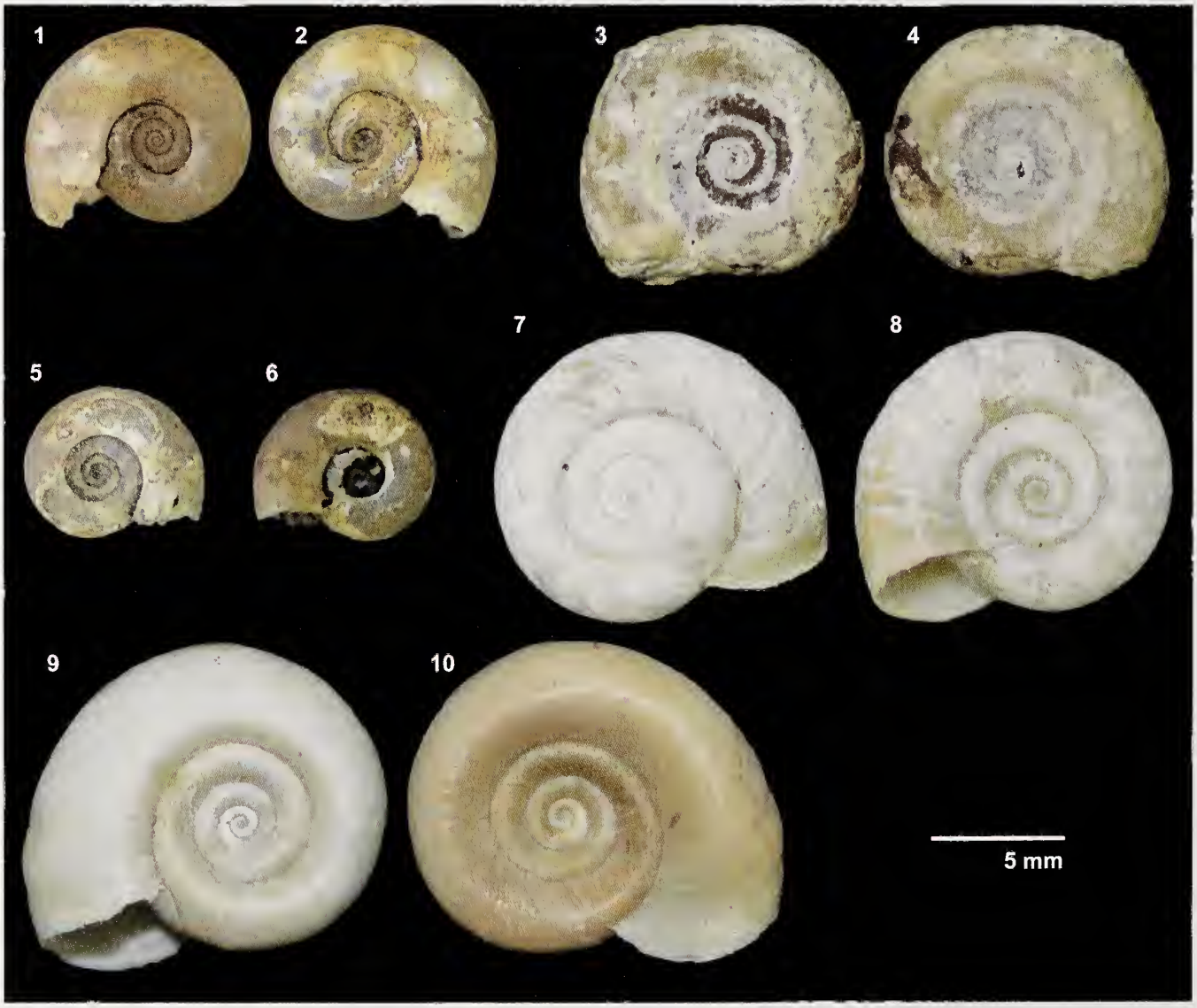
Therefore, neither Raup's parameters nor geometric morphometrics analyses can be done in shells of *Biomphalaria*. In this paper we tried a new approach for distinguishing speeies with planispiral shell. The shape of the spiral is a primary feature being used today to distinguish *a priori* different species of *Biomphalaria* (Bonetto et al., 1982, Johnston et al., 1991). In the present work,

we quantify the spiral curve, in order to test its usefulness in taxonomic differentiation among several fossil and modern species.

Three fossil and two modern species were considered (Figures 1–10). Fossil shells of *Biomphalaria walteri* (Parodiz, 1969), and two fossil species assigned to *Biomphalaria*, one of them described at the conclusion of the paper as a new species, come from the limestones of Queguay Formation (Late Cretaceous) in Uruguay. One of the undetermined fossils was previously unknown (our *Biomphalaria* sp. 1), and another erroneously allocated to *Scolodonta semperi* Doering, 1874 by Morton and Herbst (1993). This latter species is herein described as new. The modern species used for the analysis were *B. peregrina* (d'Orbigny, 1835) and *B. tenagophila* (d'Orbigny, 1835). They currently inhabit Uruguay and surrounding regions.

MATERIALS AND METHODS

The three fossil specimens mentioned above, *Biomphalaria walteri* (Figures 1, 2), *Biomphalaria* sp. 1 (Figures 3, 4), and *Biomphalaria reversa* new species (Figures 5, 6) were compared with two recent species, *Biomphalaria peregrina* (Figures 7, 8) and *Biomphalaria tenagophila* (Figures 9, 10). The fossil specimens of *Biomphalaria walteri* and part of the specimens of *Biomphalaria* sp. 1 belong to the paleontological collection of Facultad de Ciencias (Montevideo, Uruguay) FCDP (4668, 6462, 6457, 6463, 6465); the rest of the specimens of *Biomphalaria* sp. 1 (no collection number) and the specimens of *Biomphalaria reversa* new species (PZ-CTES 5345) belong to the Paleontological Collection of Universidad Nacional del Nordeste (Corrientes, Argentina).



Figures 1–10. Shells of *Biomphalaria* species. **1–2.** *Biomphalaria walteri* (Parodiz, 1969); **3–4.** *Biomphalaria* sp. 1. **5–6.** *Biomphalaria reversa* new species, holotype. **7–8.** *Biomphalaria peregrina* (d'Orbigny, 1835). **9–10.** *Biomphalaria tenagophila* (d'Orbigny, 1835). For all species, the first figure is in apical view, second figure umbilical view. Seale bar=5 mm.

The recent and Quaternary specimens of *B. peregrina* and *B. tenagophila* are hosted in the collections of Museo Nacional de Historia Natural (MNHN, Montevideo, Uruguay, no collection number); Universidad Federal de Santa Maria (Santa Maria, Brazil) (BR100888, 101084, 101888, 100747); Paleontological Collection of Facultad de Ciencias, (FCDP 2097), and in a private collection (Gustavo Lecuona collection, GLC, without collection number). In total, 143 specimens were used in this work: 30 of *B. walteri*; 14 of *Biomphalaria* 1; 33 of *Biomphalaria reversa* new species; 36 of *B. tenagophila*, and 34 of *B. peregrina*.

The 143 specimens were photographed, digitized, and the spirals highlighted. Rectangles corresponding to each of the whorls of the spiral were plotted. Next, using the program Image Tool v. 3.00 (Wilcox et al., 2002), we measured height and width of the last three whorls of each of the shells from outside in (Figure 11). We used only the last three whorls because in most fossil specimens the initial whorls were broken or had encrustations.

The value of the logarithmic spiral coefficient (θ) was calculated as: $\theta \approx AB/AD$, *AB* being the width of a whorl, and *AD* the height; although this may not the exact value of θ, it may be a good approximation. The values of θ, θ′, and θ″ were obtained for each specimen, with *AB/AD*, *A′B′/A′D′*, and *A″B″/A″D″* being the rectangles of the last three whorls (Figure 11). To obtain a unique value of θ per specimen the values were centered and standardized. Next, absolute θ values were converted to their natural logarithm to make them more comparable.

The selection of parametric or nonparametric analysis of variance (ANOVA) for analyzing the values of θ between species was determined via Shapiro-Wilk tests (SW) for normality of data and by Levene's tests (LV) for homogeneity of the variance. When deviations from normality and homogeneity were detected, a non-parametric Kruskal-Wallis test with *a posteriori* Mann-Whitney pairwise comparisons (Bonferroni corrected) test were applied (Sokal and Rohlf, 1998) to compare θ values of each species.

Then, height, width, and θ of each specimen were analyzed using Multivariate Analysis of Variance (MANOVA) and Canonical Variate Analysis (CVA) (Manly, 1994). The CVA produces a scatter-plot along the first canonical axis, showing the maximum separation between groups (multigroup discriminant analysis). The axes are a linear combination of the original values, and the eigenvalues indicate the variation of the axis and which variables contribute the most to discriminate the groups. The discriminating power of the variables was evaluated using Pillai trace because this may be more robust than Wilks lambda (Rencher, 2002). The relationship between width and height was analyzed using a linear regression model (Sokal and Rohlf, 1998), and the hypothesis of isometric growth (b = 1) was assessed applying Student t-test. PAST (v. 2.17c) (Hammer et al., 2001) was used for all statistical analysis. For all tests, the significance level used was $p=0.05$.

RESULTS

The regression model (Figure 12) between width and height was positive and significant (r = 0.99867, n=143,

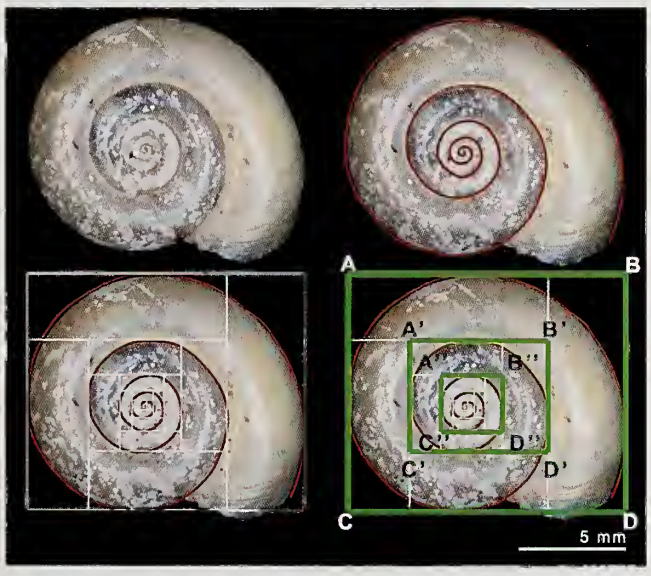


Figure 11. Step by step process to obtain θ values of the logarithmic spiral of the planispiral shell. θ can be approached by the ecuation $\theta \approx AB/AD$. The θ values of the three lasts whorls were averaged to obtain an unique value of θ for each specimen. Species: *Biomphalaria peregrina*. Scale bar=5 mm.

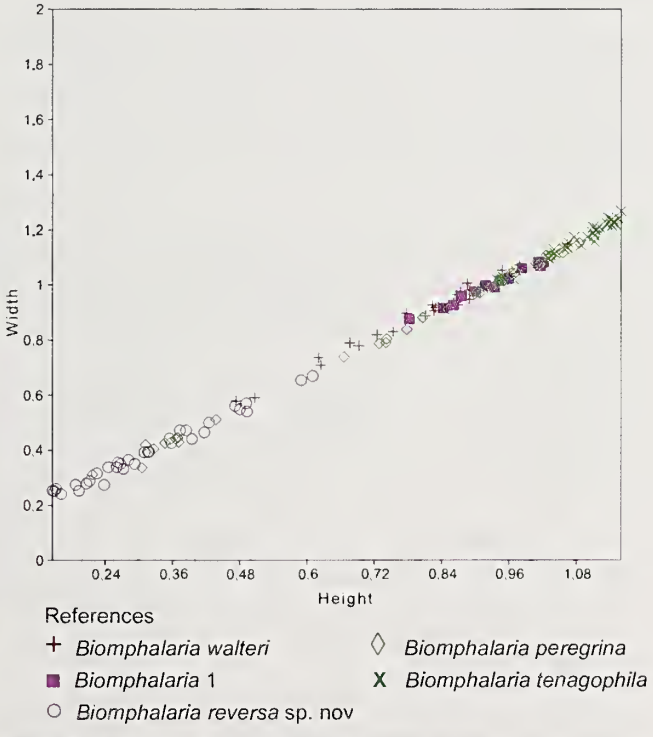


Figure 12. Regression model between width and height; r=0.99867, n=143, p<0.05, b=1.0008, s_b=0.0043523.

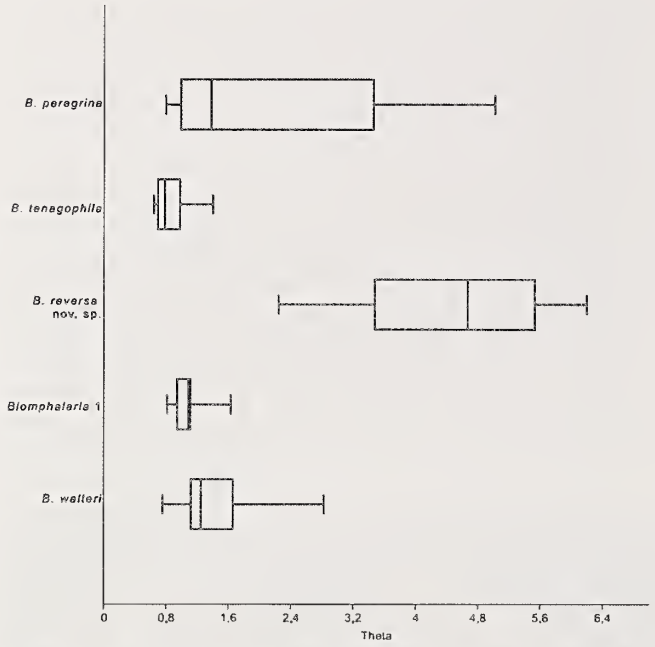


Figure 13. Box-plot of spiral coefficients (θ values) for each species. The box represents 25 and 75 percent quartiles, respectively. The median is shown with a horizontal line inside the box. The minimal and maximal values are shown with short horizontal lines ("whiskers").

$p < 0.05$) and showed an isometric shell growth when all species were considered (Figure 12) (b=1.0008, s_b=0.0043523 and p=0.85528); an allometric effect is therefore discarded.

A boxplot was performed to depict the basic statistical values of θ (Figure 13). The extant species *Biomphalaria peregrina* shows a greater dispersion than *B. tenagophila*, and this last one is bound to a restricted area of the graphic. Regarding the fossil species, *B. walteri* and *Biomphalaria* sp. 1 have almost the same dispersion, while *Biomphalaria reversa* new species is dispersed to the right of the chart and only shares part of the minimal values with the maximal values of *B. walteri*.

The θ data were non-normal (SW=0.94; p=9.64e–06), non-homogeneous among species (LV=9.8e-18; p=2.1e–38), and varied significantly among the analyzed species (Kruskall-Wallis, KW=98.52, p=2.034e–20). According to the Mann-Whitney (MW) *a posteriori* test with Bonferroni's correction, the modern species *B. tenagophila* and *B. peregrina* show differences between each other (p_{same}=1.879E–07). There is a similarity between the fossils *B. walteri* and *Biomphalaria* sp. 1 (p_{same}=0.053), and significant differences between *B. walteri* and *Biomphalaria reversa* new species (p_{same}=4.326E–10) and between *Biomphalaria* sp. 1 and *B. reversa* new species (p_{same}=8.234E–07). *Biomphalaria tenagophila* differs from all fossils as follows: *B. walteri* (p_{same}= 1.265E–07), *Biomphalaria* sp. 1 (p_{same}=0.00349), and *B. reversa* new species (p_{same}=1.008E–11). However, the fossils *B. walteri* and *Biomphalaria* sp. 1 are both similar to *B. peregrina* (p_{same}=1 with *B. walteri*, and p_{same}= 0.5528 with *Biomphalaria* sp. 1) (Table 1).

MANOVA Hotelling's p values (Bonferroni corrected) (Table 2) show significant differences between *Biomphalaria tenagophila* and *B. peregrina* (p=5.50382E–10); *B. walteri* shows differences with the remainder of the study species (p=0.0491237 with *Biomphalaria* sp. 1; p=2.35686E–16 with *Biomphalaria reversa* new species; p=4.02082E–06 with *B. tenagophila;* and p=0.000277502 with *B. peregrina*); *Biomphalaria* 1 shows differences with the other fossils but not with the extant species (p=2.69672E–12 with *Biomphalaria reversa* new species; p=0.0522732 with *B. tenagophila,* and p=0.107649 with *B. peregrina*); *Biomphalaria reversa* new species shows differences with all the species (p=1.50006E–24 with *B. tenagophila* and p=3.53252E–13 with *B. peregrina*). CVA was significant (Pillai trace=0.9918; F=17.53, p<<0.05). The first factor explains 89.55% of the total variability, and the

Table 1. Kruskal – Wallis test for θ values H (Chi^2) = 98.52; Hc (tie corrected) = 98.52; p_{same} = 2.034E-20. Mann-Whitney pairwise comparisons, Bonferroni corrected (below diagonal) \ uncorrected (above diagonal).

	B. walteri	*Biomphalaria sp. 1*	*B. reversa new species*	*B. tenagophila*	*B. peregrina*
B. walteri	0	0.0053	4.326E-11	1.265E-08	0.7183
Biomphalaria 1	0.053	0	8.234E-08	0.000349	0.05528
B. reversa nov. sp.	4.326E-10	8.234E-07	0	1.008E-12	7.133E-09
B. tenagophila	1.265E-07	0.00349	1.008E-11	0	1.879E-08
B. peregrina	1	0.5528	7.133E-08	1.879E-07	0

Table 2. MANOVA/CVA pairwise comparisons for width, height and θ. Hotelling's p values, uncorrected significance. It shows significant differences between most specimens (p-values<<α 0.05).

	B. walteri	*Biomphalaria sp. 1*	*B. reversa new species*	*B. peregrina*	*B. tenagophila*
B. walteri	0	0.0491237	2.35686E-16	4.02082E-06	0.000277502
B. sp. 1	0.0491237	0	2.69672E-12	0.0522732	0.107649
B. reversa new species	2.35686E-16	2.69672E-12	0	1.50006E-24	3.53252E-13
B. peregrina	4.02082E-06	0.0522732	1.50006E-24	0	5.50382E-10
B. tenagophila	0.000277502	0.107649	3.53252E-13	5.50382E-10	0

second the 6.2%. The variables that most contributed to distinguish among species groups were: height in the first factor and width in the second factor. CVA scatter-plot shows a well-separated *Biomphalaria reversa* new species in the left of the graphic, and *Biomphalaria* sp. 1 and *B. tenagophila* in the right. *Biomphalaria walteri* has a wide distribution in the right zone, and *B. peregrina* is distributed throughout the chart (Figure 14).

Analytical Discussion: The MW and MANOVA analyses for *Biomphalaria peregrina* and *B. tenagophila* show significant differences between the two species (Tables 1, 2). The CVA scatter-plot shows *B. peregrina* as having a wide distribution on the chart. This species shows large intraspecific variability, also recognized at the molecular level (Caldeira et al., 2001; Carvalho et al., 2001), and overlaps with the other extant species, *B. tenagophila*. Significant differenees for θ and for the other morphological variables suggest that with a simple shape as the logarithmic spiral of *Biomphalaria*, analyses of specimens of distinct species can yield similar shell shape results.

The statistical analysis of the extant species allows us to compare the statistical behavior of the fossils. *Biomphalaria walteri* and *Biomphalaria* sp. 1 do not show statistical differences, the MANOVA p-value for both is almost 0.05 (Table 2), and both show almost in the same area of the scatter plot, so there are no reasons to consider *Biomphalaria* sp. 1 as a different species from *B. walteri*. Regarding *B. reversa* new species, this fossil species presents significant differences with both *B. walteri* and *Biomphalaria* sp. 1. Moreover, in the scatter plot, the new fossil species presents a well-separated distribution in respect to the other two fossil species.

When the two extant species are compared with the fossils, θ value for *B. peregrina* is similar to the values for *B. walteri* and *Biomphalaria* sp. 1 and MANOVA test also showed similitudes to *Biomphalaria* 1 with the two extant species. *Biomphalaria reversa* new species showed significant differences with the two modern species in both statistical analysis. In the CVA scatter-plot, *B. walteri* and *Biomphalaria* 1 overlap with the two extant species, and *Biomphalaria reversa* new species overlaps with part of the distribution of *B. peregrina*.

The pairwise comparisons (MW) and the multivariate analysis of the variance (MANOVA) show that the spiral growths of *B. walteri* and *Biomphalaria* sp. 1 are almost coincident, and both differ from that of *Biomphalaria reversa* new species. When observing the results for distribution of multigroup discriminant analysis for the three fossils species in the CVA scatter plot, *Biomphalaria reversa* new species is well separated from the other two, and these overlap with each other. When the entire species set is observed in the CVA scatter plot, all of them can be considered as *B. peregrina*, so the scatter-plot by itself is not conclusive. We need to consider that *B. peregrina* is a species that shows a well-known, broad intraspecific variation, and as we used samples from Brazil and from Uruguay, perhaps regional variation is the reason for its wide distribution in the chart. Also, as mentioned before,

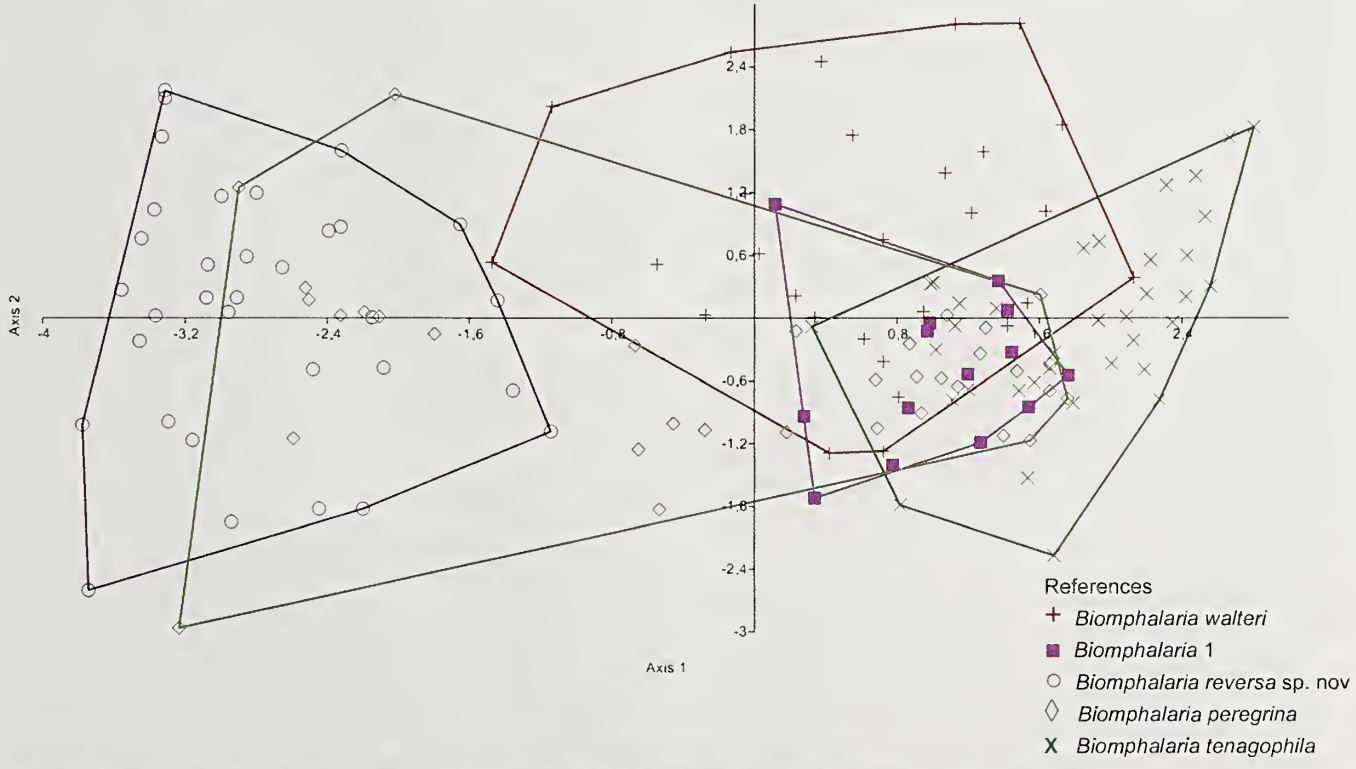


Figure 14. Canonical Variate Analysis (CVA) scatter plot for height, width and θ values for all the species.

it is expected that a simple shape as it is a logarithmic spiral could be repeated in the growth shape of different species.

To summarize, the statistical results show that the three variables explain the growth of each group as a whole. When it was expected that only θ would explain the variation, it turns out that the three variables together explain it. Hence, θ is a variable that is involved in the relative shell growth of each species, and not a variable that could explain the growth shape by itself. It is for that reason that the statistical discrimination may be complemented with qualitative morphological characteristics. This evidence leads to the formal description of a new species the new species as follows.

SYSTEMATICS

Superfamily Planorboidea
Family Planorbidae
Subfamily Planorbinae

Genus *Biomphalaria* Preston, 1910

Type Species: *Biomphalaria smithi* Preston, 1910 by monotypy.

Biomphalaria reversa new species

(Figures 5, 6, 15–17)

Scolodonta semperi.—Morton and Herbst, 1993, p. 450, pl. I, figs. 9–10) (*non* Doering, 1874)

Diagnosis: Shell very small, sub-circular in apical view, oblong in apertural view; dextral spire with four whorls. In apical view, each whorl covers part of the previous whorl. Two last whorls visible in abapical view.

Description: Shell very small, sub-circular in apical view, planispiral, oblong in apertural view; dextral spire with four convex whorls. In apical view, early whorls closely stretched, being looser and wider in last portion of spire; last whorl is larger than preceding ones, covering partially previous whorl. In umbilical view, only last two whorls visible. Umbilicus present.

Type Material: Holotype: FCDPI 7230 (Figures 5, 6, 15–17), width 6.81, height 5.79, from type locality; Paratypes, three specimens, FCDPI 7830, segregated as 7830a (Figures 18–20); 7830b (Figures 21–23); and 7830c (Figures 24–26); all from Piedras Coloradas, Paysandú Department, Uruguay (Quegay Formation, Late Cretaceous)

Type Locality: Palmar, Soriano, Paysandú Department, Uruguay (Quegay Formation, Late Cretaceous).

Other Material Examined: FCDPI 7254, 7267, 7271 (4 specimens) Trinidad, Flores Department; 7220, 7253, 7259 (107 specimens) Piedras Coloradas, Paysandú Department; 7241, 7261, 7265, 7266, 7276, 7277 (78 specimens) Quebracho, Paysandú Department; 7038, 7039 (141 specimens) Nearby Algorta Town, Río Negro Department; 7829 (65 specimens) Palmar, Soriano Department; PZ-CTES 5345 (53 specimens) Piedras Coloradas, Paysandú Department (All Queguay Formation, Late Cretaceous).

Geographic and Stratigraphic Ranges: Nearby Algorta Town, Río Negro Department; Trinidad, Flores; Palmar, Soriano; Quebracho Town and proximities of Piedras Coloradas Town, Paysandú Department, Uruguay (All Queguay Formation, Late Cretaceous).

Etymology: Latin *reversa*, reverse, in referenee to the dextral shell orientation, in opposition to the sinistral orientation of the closest fossil species.

Comparative Remarks: The specimens allocated to *Scolodonta semperi* by Morton and Herbst (1993) represent *Biomphalaria reversa* new species. These specimens do not fit the description of *Scolodonta semperi* nor of any *Scolodonta* for that matter (Döring, 1875; Hausdorf, 2006). Species of *Scolodonta* have a discoidal shell with slowly increasing whorls and slightly raised spire (together with soft parts characters that are obviously only observable in recent species.) None of these characteristies are present in the fossil speeimens, their characters closely resembling those of *Biomphalaria* (see below).

Biomphalaria reversa new species has its spiral growth very similar to *B. walteri*. However, it is clearly smaller than *B. walteri*. Additionally, *B. reversa* new species is dextral, and *B. walteri* is sinistral. *Biomphalaria reversa* has less whorls than *B. walteri* as well. In apertural view, *B. reversa* new species is more oblong and flattened than *B. walteri*.

The recent species *Biomphalaria peregrina* is similar to *B. reversa* new species in spiral growth and general shell shape (Figures 15–32). Additionally, both are dextral. However, *B. peregrina* is larger than *B. reversa* new species, and *B. peregrina* has more than six eircular whorls with well-defined sutures, while *B. reversa* has four slightly convex whorls, with barely visible sutures.

Biomphalaria tenagophila is larger than *Biomphalaria reversa* new species and has a sinistral spire with elevated and angled whorls, while *B. reversa* new species has "softer" and rounded whorls. The spiral coefficients showed significant differences between both species.

CONCLUSIONS

The analysis of the logarithmic spiral of the planispiral shells of the fossil and extant *Biomphalaria* species in this study, combined with shell width and height, describes the different spiral growth patterns in different species. Also, the analysis is useful as a complementary character for species identification, but not signifieant enough to be used by itself. Therefore, to make decisions about specimen identification, qualitative morphological characters had to be used. In fact, the quantitative

Figures 15–32. Shells of *Biomphalaria* species. **15–26.** *Biomphalaria reversa* new species, shells in apical, umbilical, and apertural view. **15–17.** Holotype (FCDPI 7230). **18–20.** Paratype a (FCDPI 7830a). **21–23.** Paratype b (FCDPI 7830b). **24-26.** Paratype c (FCDPI 7830c). **27–32.** *Biomphalaria walteri*, shells in apical, umbilical, and apertural view. **27–29.** Holotype, Carnegie Museum of Natural History, Pittsburgh (CM 103839) (courtesy of Dr. Timothy Pearce). **30–32.** FCDPI 6457. Scale bars: 1mm.

analysis and the traditional qualitative analysis complement each other in the definition of species in the genus *Biomphalaria*.

A new species is described as a result of the combined approaches of statistical analysis and traditional morphological description: *Biomphalaria reversa* new species, from the Queguay Formation (Late Cretaceous) of Uruguay. This new species is added to the freshwater assemblage of this lithostratigraphic unit, constituting, with *B. walteri*, the oldest representatives of *Biomphalaria* worldwide.

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Three new species of Neogene *Truncatella* Risso, 1840 (Gastropoda: Truncatellidae) from Florida, USA

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ABSTRACT

Three new species of truncatellid gastropods are described and illustrated. Two species are from the lower Miocene Chipola Formation of Calhoun County, Florida, and one is from upper Pliocene to lower Pleistocene deposits of the upper? Pinecrest beds, Tamiami Formation of Sarasota County, Florida. All three new species are believed to have inhabited shallow water, marine environments.

INTRODUCTION

Gastropods of the family Truncatellidae display the ability to traverse vast distances of ocean to populate tropical and warm temperate environments. This ability to inhabit distant shorelines is accomplished by attaching themselves or egg capsules to various pieces of flotsam and riding ocean currents. Once established on a new shoreline, most truncatellids live at the high tide line, where they reside under protective material such as seaweeds, rocks, and boards. The distribution of truncatellid species within any particular region has been found to be irregular and appears to be due to how groups of individuals are transported ashore by flotsam (Clench and Turner, 1948). Life history information regarding amphibious forms shows that they lay their egg eapsules on supratidal detritus, are capable of digesting cellulose, and possess the ability to estivate for several months while away from water (Rosenberg, 1996). Populations of truncatellids have colonized terrestrial habitats where they survive under leaf litter at elevations as high as 600 meters (Rosenberg, 1996). Today, in Florida and the Gulf Coast region of the USA, only three species are known: *Truncatella caribaeensis* Reeve, 1842, *Truncatella clathrus* Lowe, 1832, and *Truncatella pulchella* Pfeiffer, 1839. Herein, we deseribe three new species of *Truncatella* from the Neogene of Florida. Studies of the collecting sites (Vokes, 1989) where the new fossil species were discovered indieate that they were shallow water, marine environments.

MATERIALS AND METHODS

Specimens of *Truncatella* species from the lower Miocene Chipola Formation were collected from two localities in the Florida Museum of Natural History, Invertebrate Paleontology Division (FLMNH IP) Directory along the Chipola River in Calhoun County, Florida (Figure 1). One specimen was removed from matrix at FLMNH IP CA004, and two were collected from submerged deposits at FLMNH IP CA018. All sampled sediments were *in situ*. Furthermore, from the latter site, pieces of loosely consolidated fossiliferous sandstone were removed from underwater ledges with the aid of SCUBA. After removal, the material was brought to the FLMNH IP laboratory for serial screen washing, air dried, and then sediments were picked under stereomicroscope. From FLMNH IP CA018, one specimen (UF 71914) came from the lowest ledge near the bottom of the river, and one specimen (UF 71913) was from the uppermost underwater ledge. The 18 Tamiami Formation (upper? Pinecrest beds) specimens (UF 71915 –71917, UF 81225, and UF 261371) were all sieved from spoil (float) at FLMNH IP locality SO001 in Sarasota County, Florida. The material is most likely from the upper Pinecrest beds of early Pleistocene age. This assessment is based on a current, highly detailed examination of the *in situ* lower Pinecrest beds fauna which shows no presence of truncatellids (Lee et al., in preparation).

Specimens in Figures 2–7 were mounted to SEM stubs, sputter coated with gold-palladium, and imaged using a Hitachi field emission scanning electron microscope and later re-imaged using a Zeiss EVO MA 10 scanning electron microscope. In both instances, linear dimensions were determined by the SEM's hardware and software, respectively. All SEM images were then processed in Photoshop 6 for the plate layout. Fossil specimens were compared to the three recent species

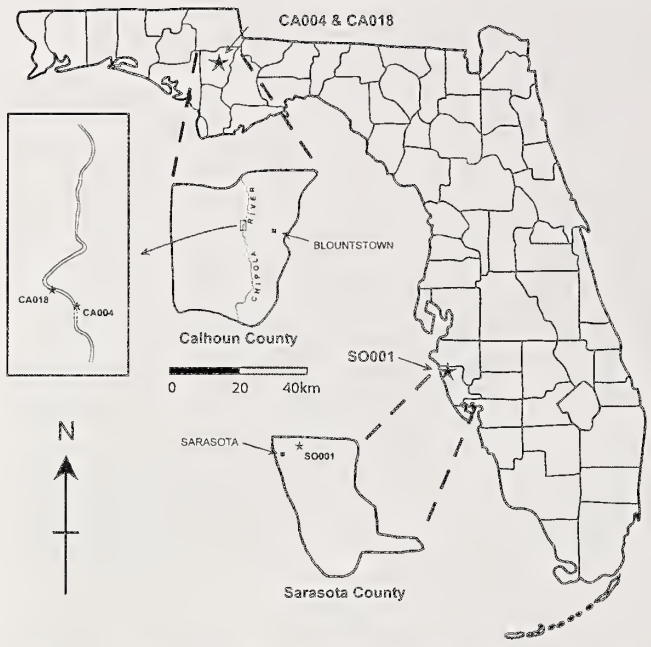


Figure 1. Map showing collecting localities of the three new Neogene species of *Truncatella*.

(listed above) borrowed from the FLMNH Invertebrate Zoology Division.

SYSTEMATICS

Superfamily Rissooidea Gray, 1847
Family Truncatellidae Gray, 1840

Genus *Truncatella* Risso, 1826

Type Species: *Truncatella laevigata* Risso, subsequent designation, Gude, 1921 (= *Helix subcylindrica* Linné, 1767: 1248).

Truncatella chipolana new species
(Figures 2–3)

Description: Shell minute, elongate-cylindrical with 4 moderate to highly convex whorls. Suture strongly impressed, whorls of nearly equal size giving shell a somewhat straight-sided appearance. Whorls with well-developed, rounded, evenly spaced, opisthocline ribs that extend to sutures (21 on body whorl of holotype and 26 on body whorl of paratype). Shell imperforate, aperture holostomatous and ovate, surrounding lip thickened, inner lip not adnate with parietal area.

Type Material: Holotype: UF 71914, maximum height 4.62 mm, from type locality; Paratype: UF 122257 from FLMNH IP locality CA004, Chipola Formation, USA, Florida, Calhoun County, east bank of Chipola River (30.451388, –85.160166, datum WGS84).

Type Locality: FLMNH IP locality CA018, Chipola Formation, USA, Florida, Calhoun County, west bank of Chipola River (30.4535, –85.163722, datum WGS84).

Distribution: *Truncatella chipolana* is an extremely rare species that has been collected from only two localities. The holotype comes from very rich (in abundance and diversity) deposits along the Chipola River that have yielded the remains of both marine and terrestrial gastropods. At the Type section, the holotype was derived from the lower bed.

Etymology: Named for the Chipola River, where the specimens were excavated and collected.

Remarks: *Truncatella chipolana* is similar to *T. pulchella*. Like *T. chipolana*, *T. pulchella* has an elongate form, possesses about 20–26 opisthocline ribs on the body whorl, and has an inner lip that is not attached to the parietal area. However, the two differ in that the *T. pulchella* has more tapering whorls (not as straight-sided), axial ribs less opisthocline and ribs much sharper (although degree of sharpness may be a function of abrasion on the fossil specimens), a narrower peristome, and more oval aperture.

Truncatella andymurrayi new species
(Figures 4–5)

Description: Shell minute, with 3 cylindrical, slightly impressed body whorls. Sutures distinct, body whorls variable in size. Narrow prosocline axial ribs extending between the sutures on first whorl only. Remaining whorls with ribs near sutures of each whorl (28 on the body whorl of holotype). Shell imperforate, aperture holostomatous and ovate, surrounding lip moderately thickened, inner lip not adnate with parietal area.

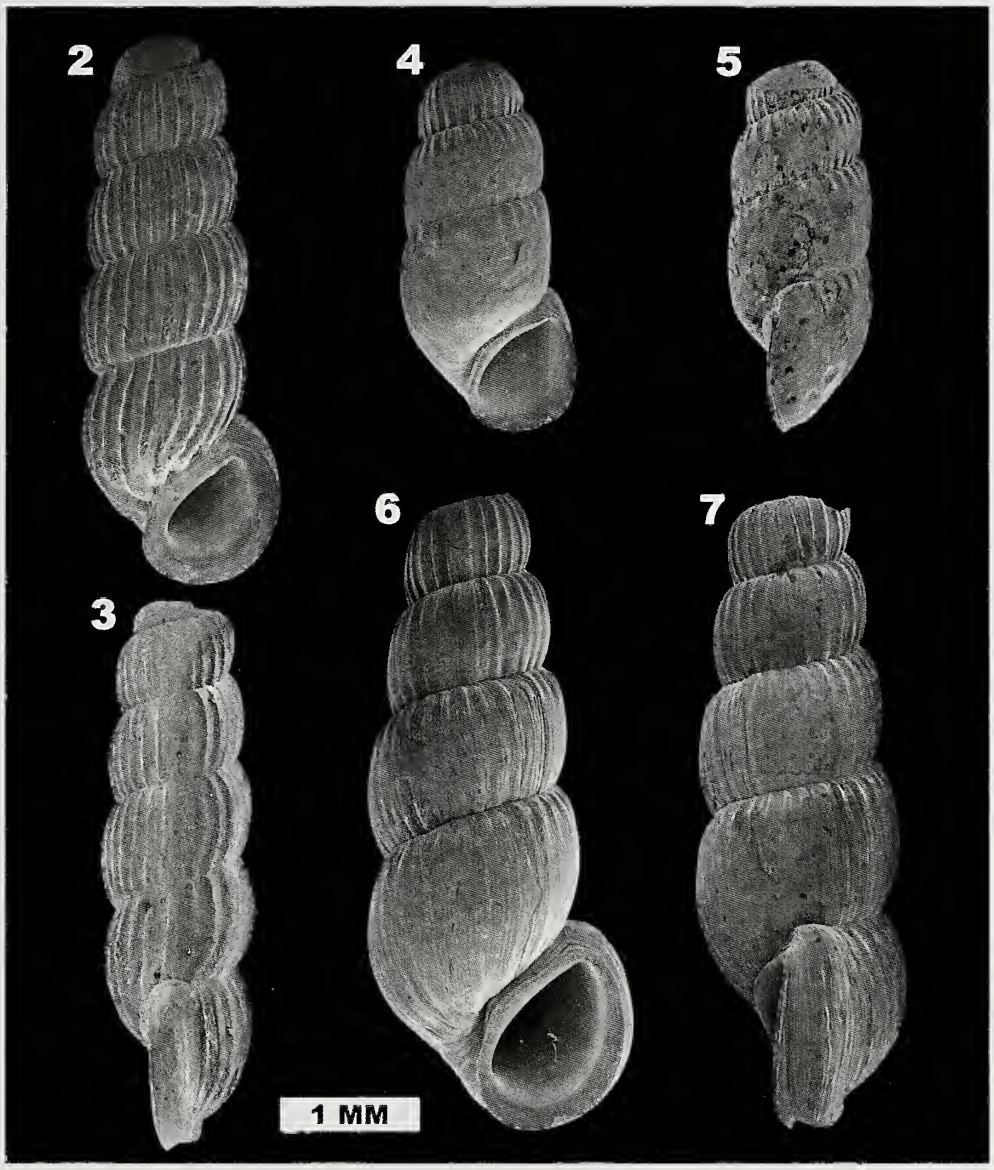
Holotype: UF 71913, maximum height 3.12 mm.

Type Locality: FLMNH IP locality CA018, Chipola Formation, USA, Florida, Calhoun County, west bank of Chipola River (30.4535, –85.163722, datum WGS84).

Distribution: *Truncatella andymurrayi* is known only from the holotype, which also comes from very rich (in abundance and diversity) deposits along the Chipola River. At the Type section, the holotype was derived from the upper bed.

Etymology: Named for Mr. Andy Murray an avid collector of Chipola Formation mollusks.

Remarks: Overall body configuration of *T. andymurrayi* is most similar to *T. caribaeensis*, a *Truncatella* species incorrectly identified and illustrated as *T. pulchella* by Clench and Turner (1948: 156–157, pl. 58, figs. 4–6) and correctly identified as *T. caribaeensis* by De La Torre (1960: 80) and Rosenberg (1989). *Truncatella andymurrayi*, however, is a much smaller species than *T. caribaeensis*, and its whorls are less bulbous. Although both the smooth form of *T. caribaeensis* and *T. andymurrayi*



Figures 2–7. New Florida Neogene *Truncatella* species, in apertural and right lateral views. **2–3.** *Truncatella chipolana* new species, Holotype (UF 71914). **4–5.** *Truncatella andymurrayi*, new species, Holotype (UF 71913). **6–7.** *Truncatella sarasotaensis*, new species, Holotype (UF 71917). Scale bar = 1.0 mm.

possess ribs that do not extend across the whorls, it is possible that some of the ribs are less pronounced on *T. andymurrayi* as a result of abrasion/erosion of the shell, however the strongest sculpture is on the older (apex) of the shell arguing against this supposition.

***Truncatella sarasotaensis* new species**
(Figures 6–7)

Description: Shell minute, tapered body profile with 4 elongate-cylindrical convex whorls. Apical whorls missing in holotype. Suture distinct, deeply impressed. All specimens possess narrow, slightly opisthocline axial ribs (26 on body whorl of holotype) that typically extend across whorls to sutures. Shell imperforate, parietal wall thickened by inner lip, aperture holostomatous, ovate and somewhat flaring.

Type Material: Holotype: UF 71917, maximum height 5.36 mm. Paratypes: UF 71915 (two specimens), UF 71916, maximum height 4.23 mm (one specimen), UF 81225, maximum height 4.36 mm (one specimen) and UF 261371 (13 whole and fragmented specimens), all from type locality.

Type Locality: FLMNH IP locality SO001 (MacAsphalt Shell Pit), Tamiami Formation (upper? Pinecrest beds), USA, Florida, Sarasota County (27.366642, –82.451008, datum WGS84).

Distribution: *Truncatella sarasotaensis* was found by sieving material collected in spoil piles between 1987 and 1990. Although it was not uncommon at FLMNH IP locality SO001, this species has yet to be reported from other, similarly aged, Florida locations.

Etymology: Named for the city of Sarasota where the now water-filled quarry is located.

Remarks: *Truncatella sarasotaensis* is most similar to *T. pulchella*. Like *T. pulchella, T. sarasotaensis* has angular body whorls with numerous evenly spaced axial ribs. However, unlike *T. pulchella*, *T. sarasotaensis* is a larger species, has more bulbous whorls, and much less pronounced ribs, although the latter character may be, in part, a function of abrasion on the fossil specimens.

DISCUSSION

Truncatella chipolana and *T. andymurrayi* represent the oldest New World truncatellids found to date (circa 18 million years old). The California Pleistocene truncatellid reported by Grant and Gale (1931) is currently the only known fossil *Truncatella* from the USA. *Truncatella sarasotaensis* is of comparable age to its California counterpart, and fossils found associated with it are mostly intertidal species.

ACKNOWLEDGMENTS

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Zeitschrift für Malakozoologie (1844–1853): A history and collation

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ABSTRACT

The *Zeitschrift für Malakozoologie*, the first modern German malacological serial, appeared in 10 volumes and 120 issues from 1844 through 1853, and contained the descriptions of numerous new species of mollusks from around the world. Due to the 1848 German Revolution, and other publication delays, the dating of a number of issues has been problematic. This paper provides a collation of the 120 issues and a determination of the date of each issue, in accord with the *International Code of Zoological Nomenclature*.

INTRODUCTION

Germany is home to the earliest malacological journal—several short-lived serials authored and published by J. S. Schröter from 1770 to 1789 (Bieler and Kabat, 1991: 39, 44). However, the first German malacological journal in a modern sense—with editors and contributions from multiple authors—was the *Zeitschrift für Malakozoologie*, founded in 1844 by Karl Theodor Menke (1791–1861), who lived in Pyrmont (now Bad Pyrmont, Niedersachsen) (Jungbluth et al., 1991: 92–93). The first two volumes were edited by Menke alone, and were printed in Hannover by Hahn'sche Hofbuchhandlung. Menke (1844: 1–11) began the first issue of this serial with a lengthy essay that surveyed the malacological literature to date, and closed with the hope that his ambitions for this new journal and its readers would be satisfied.

Louis Pfeiffer (1804–1877), of Cassel, became a co-editor commencing with volume 3 for 1846, and the journal was printed by Theodor Fischer, a publishing house in Cassel known for a number of other malacological publications, as well as other natural history and geological titles.

In 1853, the *Zeitschrift* was replaced by the *Malakozoologische Blätter*, which was published in two series from 1853 through 1891 (Bieler and Kabat, 1991: 44; Bürk and Jungbluth, 1985: 339–340). According to the editors, the *Malakozoologische Blätter* was intended to allow for a broader scope of submissions and more frequent illustrations (Menke, et al., 1853: [vi]–[viii]).

In 1854, the second volume of the *Zeitschrift*, which had been out-of-print for some years, was reprinted by the original publisher (Menke, 1854: 48). In 1969, the *Zeitschrift* and the *Malakozoologische Blätter* were reprinted in their entirety by Otto Koeltz (Koenigstein-Taunus). Sometime after 2005, the *Zeitschrift* was digitized by the Biodiversity Heritage Library (the set in the Smithsonian Institution), HathiTrust (the set in the University of Michigan) and Google Books (the set in the University of Illinois).

In the 1840s, Cassel (known as Kassel since 1926), then the capital of northern Hesse, was an important malacological research center, as a number of malacologists lived there or nearby (Jungbluth, 2011), including Louis Pfeiffer, Rudolph Amandus Philippi (1808–1904), Wilhelm Dunker (1809–1885), Friedrich Carl Ludwig Koch (1799–1852), as well as Israel Heyman Jonas (1795–1851, from Hamburg), all of whom contributed to the *Zeitschrift*. During its ten years, the journal published the descriptions of somewhere around 1,000 new species, of which at least half were described by Philippi alone.

Each volume contained 12 issues, originally intended to appear on a monthly basis. Except for volume 2, each issue comprised a fascicle of 16 pages, so that the entire volume consisted of 192 pages, with an additional 4 to 9 pages (with Roman-numbered pages) issued after the end of the volume and comprising the table of contents and index. Volume 2 consisted of 198 pages, with issue 2(7) having 18 pages and issue 2(12) having 20 pages.

The individual issues were not originally distributed with wrappers, so that the first page of each issue had both a header with the journal title and the names of the editor(s), and the text of the first article. One set that we have examined in a private library does have wrappers on thicker, cardstock paper for each volume, with the journal name and volume number printed in large type. However,

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those wrappers were made using the back side of advertising circulars bearing an "1879" date, nearly three decades later.

In several articles, some or all of the footnotes are by the editor (Menke or Pfeiffer), not by the author of the article. The editors sometimes used their footnotes to criticize the conclusions reached by the author of the article, or otherwise to comment on the article. For example, in 3(1): 12, an article by Jonas on *Proserpina* has two footnotes, the first by Jonas and the second by Pfeiffer. Issue 2(1), pages 1–14, had a lengthy article (in French) by Gerard P. Deshayes, written in response to a critique by Menke of the Deshayes edition of the *Histoire naturelle des animaux sans vertebres* that Menke published in volume 1 of the *Zeitschrift*. In the Deshayes article, Menke then added 26 footnotes of his own in order to rebut the points made by Deshayes.

Only two plates were issued with this journal, in issue 7(1) (April 1850) (reproductive "darts" of *Helix*, for an article by A. Schmidt); and issue 9(12) (December 1852) (illustrations for several articles by Pfeiffer, mostly terrestrial gastropods from Cuba). Bürk and Jungbluth (1985: 338) stated that volume 10 also had "1 Bildnis" (portrait) of Louis Pfeiffer, but we have not seen any such portrait of Pfeiffer in any of the four sets of this work that we have examined; the sets in the Naturmuseum Senckenberg (Frankfurt) and the Field Museum of Natural History (Chicago) also do not have such an illustration (R. Janssen, *in litt.* 10 Aug. 2015; R. Bieler, *in litt.* 17 Aug. 2015).

The dating of this journal has created some problems in the literature, and we attempt to rectify this confusion as best as is now possible, as set forth in the table and summarized below:

1. Originally, each issue had two dates – the "month and year" on the first page, and the exact month, day, and year on the last page, as used in 1(1) through 1(7).
2. Starting with 1(8) (August 1844) through 2(2) (February 1845), the date on the last page became a more generic "Ende" or "Mitte" of a given month.
3. For 2(3) through 2(12), the date on the last page was just a given month and year, with no specific day indicated.
4. For 3(1) (1846) through 5(6) ("1848"), no end date was given, so that the only date is the month/year stated on the first page. As noted in the table below, internal evidence allowed us to date several of these issues more precisely.
5. For 5(7) ("1848") through 10(12) (1853), the first page only provided the year and the issue number; 12 of the issues had no end date, while the last page in all but 12 of the issues gave at least the month and year, with 8 issues giving the month, day and year.

Based on internal evidence, *i.e.*, advertisements for books that were published on a specific date, or the date of submission of several manuscripts or letters to the editor, and interpolation with dated issues, we were able to estimate dates for the 12 issues without any date other than the stated year.

Critically, volumes 5 (for 1848) through 8 (for 1851) were published at and after the time of the March 1848 Revolution in Germany, which resulted in significant turmoil over the next three years (and led to R.A. Philippi escaping from Germany to Chile in 1851). This Revolution and its aftermath must have significantly disrupted the printing of this and other scientific journals. As set forth in the table, several issues in those volumes were stated on the last page to have been published in the year *after* the year printed on the first page of those issues. Further, issues 6, 7, and 8 of Volume 5 (nominally issued for 1848) had advertisements for a publication available in January 1849, suggesting a publishing date in early 1849. Issue 5(7) had an editorial note on page 112 by Pfeiffer which cryptically referred to the Revolution: "Die durch bekannte Hemmnisse im Jahre 1848 verzögerte Ausgabe der einzelnen Blätter der Zeitschrift wird nunmehr möglichst schnell nachgeholt werden." [The publication of issues delayed due to known hindrances in 1848 will now be resumed as quickly as possible].

Similarly, several issues in volume 6 (nominally issued for 1849) had articles submitted in January 1850, and the last three issues of volume 6 were expressly dated in early 1850.

Volume 7 ("1850") had only the first seven issues appearing in 1850.

Volume 8 ("1851") had at least one issue appearing in 1852.

Volumes 9 and 10 (for 1852 and 1853, respectively, after the Revolution was over and the federal authorities were fully in control of Germany), were back on schedule, with each volume being completed within the stated year. Even then, the issues did not appear on an exact monthly schedule, with multiple issues appearing in the same month (e.g., three issues were published in July 1852 and another three issues published in November 1853).

Pursuant to ICZN *Code* Article 21, we have set forth dates that we recommend be used for each issue of this journal—either the exact day, month, and year (17 issues), or the last day of the month for issues with the month known or determined but without a known day of publication (98 issues), or the last day of the year for issues without a known or determined month (5 issues). For two of the issues, 8(3) (indicated as "July 1851") and 9(5) (indicated as "June 1852"), since the following issues came out in the same months, *i.e.*, 8(4) (15 July 1851) and 9(6) (12 June 1852), we used the latter dates for the former issues. Of the 120 issues, 18 (in volumes 5, 6, 7, and 8) are known or determined to have been published in the year *after* the nominal year for the volume.

In the following table, the right-hand column has the actual or determined date of publication. Entries without an asterisk are actual dates; entries with a single asterisk (*) are the last day of the month (ICZN *Code* Article 21.3.1); entries with a double asterisk (**) are the last day of the calendar year (ICZN *Code* Article 21.3.2).

Volume / Issue	For month of	Pages	Date on last page of issue	Date of Publication (ICZN)
1 – 1844		i–viii	Title page dated 1845	
1	January	1–16	January 15, 1844	15 January 1844
2	February	17–32	February 16, 1844	16 February 1844
3	March	33–48	March 16, 1844	16 March 1844
4	April	49–64	April 10, 1844	10 April 1844
5	May	65–80	May 25, 1844	25 May 1844
6	June	81–96	June 25, 1844	25 June 1844
7	July	97–112	July 30, 1844	30 July 1844
8	August	113–128	"Ende August"	31 August 1844*
9	September	129–144	"Ende September"	30 September 1844*
10	October	145–160	"Ende October"	31 October 1844*
11	November	161–176	"Ende November"	30 November 1844* (page 176 has a note from Jonas, dated 19 November 1844).
12	December	177–192	"Mitte December"	31 December 1844*
2 – 1845		i–viii	Title page dated 1846	
1	January	1–16	"Mitte January"	31 January 1845*
2	February	17–32	"Ende February"	28 February 1845*
3	Mareh	33–48	April	30 April 1845*
4	April	49–64	June	30 June 1845*
5	May	65–80	"April" [*sic*]	30 June 1845* (page 67 has an article by Jonas submitted in May 1845).
6	June	81–96	July	31 July 1845* (page 91 has an article submitted in April 1845; page 95 has an article submitted 22 June 1845).
7	July	97–114	August	31 August 1845*
8	August	115–130	October	31 October 1845*
9	September	131–146	November	30 November 1845*
10	October	147–162	November	30 November 1845*
11	November	163–178	December	31 December 1845*
12	December	179–198	December	31 December 1845*
3 – 1846		i–viii	Title page dated 1846	
1	January	1–16	No end date	31 January 1846*
2	February	17–32	No end date	28 February 1846* (page 18 has an article submitted December 1845).
3	March	33–48	No end date	31 March 1846*
4	April	49–64	No end date	30 April 1846*
5	May	65–80	No end date	31 May 1846* (page 73 has an article submitted on 11 April 1846).
6	June	81–96	No end date	30 June 1846*
7	July	97–112	No end date	31 July 1846* (page 112 has an obituary submitted on 22 April 1846).
8	August	113–128	No end date	31 August 1846*
9	September	129–144	No end date	30 September 1846*
10	October	145–160	No end date	31 October 1846*
11	November	161–176	No end date	30 November 1846* (page 174 has an article submitted on 22 October 1847).
12	December	177–192	No end date	31 December 1846*
4 – 1847		i–vii	Title page dated 1847	
1	January	1–16	No end date	31 January 1847*
2	February	17–32	No end date	28 February 1847*
3	March	33–48	No end date	31 March 1847*
4	April	49–64	No end date	30 April 1847*
5	May	65–80	No end date	31 May 1847*
6	June	81–96	No end date	30 June 1847*
7	July	97–112	No end date	31 July 1847*
8	August	113–128	No end date	31 August 1847*
9	September	129–144	No end date	30 September 1847*

(*Continued*)

Volume / Issue	For month of	Pages	Date on last page of issue	Date of Publication (ICZN)
10	October	145–160	No end date	31 October 1847*
11	November	161–176	No end date	30 November 1847*
12	December	177–192	No end date	31 December 1847*
5 – 1848		i–vii	Title page dated 1849	
1	January	1–16	No end date	31 January 1848* (?)
2	February	17–32	No end date	29 February 1848* (?)
3	March	33–48	No end date	31 March 1848* (?)
4	April	49–64	No end date	30 April 1848* (?)
5	May	65–80	No end date	31 May 1848* (?)
6	June	81–96	No end date	31 January 1849* (page 96 has an advertisement dated "10. Januar 1849" for Philippi's *Abbildungen und Beschreibungen*, 3(4)).
7		97–112	No end date	31 January 1849* (page 112 has an advertisement dated "30. Januar 1849" for the 10th Lieferung of Herrmannsen, *Indicis Generum Malacozoorum Primordia*.).
8		113–128	No end date	31 March 1849* (page 123 notes that Philippi's article is "Continuato Febr. 1849", i.e., continued from 5(7): 112 (previous entry); page 128 has an advertisement dated "10. März 1849" for volume 2 of Hermannsen, *Indicis Generum Malacozoorum Primordia*.
9		129–144	March 1849	31 March 1849*
10		145–160	March 1849	31 March 1849*
11		161–176	March 1849	31 March 1849*
12		177–192	April 1849	30 April 1849*
6 – 1849		i–vii	Title page dated 1850	
1		1–16	March [*sic*, May] 1849	31 May 1849*, since the previous issue, 5(12), is dated "April 1849."
2		17–32	May 1849	31 May 1849*
3		33–48	July 1849	31 July 1849* (page 48 has an advertisement dated Juli 1849 for Lieferungen 80–81 of the *Systematisches Conchylien-Cabinet*).
4		49–64	No end date	31 August 1849* (page 53 has an article by A. Schmidt submitted July 1849).
5		65–80	November 1849	30 November 1849* (page 80 has an article by E. A. Rossmässler submitted October 1849).
6		81–96	No end date	30 November 1849* (page 96 has an advertisement dated November 1849 for Lieferungen 82–86 of the *Systematisches Conchylien-Cabinet*).
7		97–112	No end date	31 December 1849**
8		113–128	No end date	31 January 1850* (page 120, has an article by Lovell Reeve submitted January 5, 1850).
9		129–144	No end date	28 February 1850* (page 144 has an article by A. Schmidt submitted January 1850).
10		145–160	March 1850	31 March 1850*
11		161–176	March 1850	31 March 1850*
12		177–192	April 1850	30 April 1850*
7 – 1850		i–vii	Title page dated 1851	
1		1–16, 1 pl.	April 1850	30 April 1850* (page 13, article by A. Schmidt submitted in January 1850).
2		17–32	April 1850	30 April 1850*
3		33–48	May 1850	31 May 1850* (page 148 has an advertisement for Philippi's *Abbildungen und Beschreibungen*, 3(7), which has a print date of April 1850).

(*Continued*)

Volume / Issue	For month of	Pages	Date on last page of issue	Date of Publication (ICZN)
4		49–64	June 1850	30 June 1850*
5		65–80	July 1850	31 July 1850*
6		81–96	August 1850	31 August 1850*
7		97–112	November 2, 1850	2 November 1850
8		113–128	February 1851	28 February 1851* (page 120 has an article submitted by A. Schmidt in December 1850).
9		129–144	February 1851	28 February 1851* (page 144 has a "Nachruf" noting Philippi's unexpected departure, i.e., his escape to Chile).
10		145–160	March 1851	31 March 1851*
11		161–176	April 1851	30 April 1851*
12		177–192	April 1851	30 April 1851*
8 – 1851		i–[vii]	Title page dated 1852	
1		1–16	May 1851	31 May 1851*
2		17–32	June 1851	30 June 1851*
3		33–48	July 1851	15 July 1851 (based on known date of next issue)
4		49–64	July 15, 1851	15 July 1851
5		65–80	July 1851	31 July 1851*
6		81–96	August 1851	31 August 1851*
7		97–112	September 1851	30 September 1851*
8		113–128	No end date	31 December 1851**
9		129–144	No end date	31 December 1851**
10		145–160	No end date	31 December 1851**
11		161–176	No end date	31 December 1851**
12		177–192	January 15, 1852	15 January 1852 (page 184 has an article by A. Schmidt submitted in November 1851).
9 – 1852		i–vi	Title page dated 1853	
1		1–16	February 15, 1852	15 February 1852
2		17–32	March 25, 1852	25 March 1852
3		33–48	March 26, 1852	26 March 1852
4		49–64	May 12, 1852	12 May 1852
5		65–80	June 1852	12 June 1852 (based on known date of next issue).
6		81–96	June 12, 1852	12 June 1852
7		97–112	July 1852	31 July 1852*
8		113–128	July 1852	31 July 1852*
9		129–144	July 1852	31 July 1852*
10		145–160	September 1852	30 September 1852*
11		161–176	October 1852	31 October 1852*
12		177–192, 1 pl.	December 1852	31 December 1852*
10 – 1853		i–vi + [vii–viii]	Title page dated 1853	"Prospectus" on page [viii], for the *Malakozoologisches Blätter* dated December 1853
1		1–16	January 1853	31 January 1853*
2		17–32	January 1853	31 January 1853*
3		33–48	February 1853	28 February 1853*
4		49–64	March 1853	31 March 1853*
5		65–80	July 1853	31 July 1853*
6		81–96	July 1853	31 July 1853*
7		97–112	August 1853	31 August 1853*
8		113–128	August 1853	31 August 1853*
9		129–144	November 1853	30 November 1853*
10		145–160	November 1853	30 November 1853*
11		161–176	November 1853	30 November 1853* (page 176 has an article by A. Schmidt submitted on 8 November 1853).
12		177–192	December 1853	31 December 1853* (page 189 has an article by L. Pfeiffer submitted on 12 December 1853).

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Identification and redescription of the Haitian *Chondropoma semilabre* of Bartsch, 1946, *non* Lamarck, 1822 (Gastropoda: Annulariidae)

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ABSTRACT

Chondropoma bellavittatum new species is described for the Haitian species referred to by Bartsch, 1946, as *Chondropoma semilabre* Lamarck, 1822. This latter species is shown to be a different taxon from the Bahamas.

INTRODUCTION

Lamarck (1822) briefly described *Cyclostoma semilabris* from an unknown locality, thus launching a convoluted nomenclatorial history for the species involving misidentifications from numerous authors. Eventually, Pfeiffer (1862) noted the species' great similarity to *Chondropoma hjalmarsoni* Pfeiffer, 1858, from Turks Island, Bahamas [Turks and Caicos Islands], but identified it as a related but distinct species from Crooked Island, Bahamas. Pfeiffer does not mention seeing Lamarck's specimen. Weinland (1880) followed Pfeiffer in considering Lamarck's species as originating from Crooked Island.

Bartsch (1946), in his lengthy discussion of *C. semilabre*, does not mention having seen the type specimen but maintained that it was a Haitian taxon matching specimens at the United States National Museum (now National Museum of Natural History, Smithsonian Institution) from Saint-Marc and Arcahaie. He considered the Crooked Island species to be *Chondropoma glabratum* Reeve, 1863, described from "Bahamas." Reeve attributed the species to Weinland, who however did not describe it.

Mermod's (1952: fig. 109) photograph of the type of *Cyclostoma semilabris*, now at Muséum d'Histoire Naturelle de Genève (unnumbered), confirmed Pfeiffer's assessment that it is conchologically similar to *C. hjalmarsoni*; in fact, it seems identical to *Chondropoma hjalmarsoni salinum* Bartsch, 1946, which is not from Crooked Island but from Salt Cay in the Turks and Caicos Islands group. The type is also similar to *Chondropoma glabratum* Reeve, 1863. Although Bartsch identified Reeve's species as the Crooked Island taxon, it is actually more similar to the Salt Cay species, and may be a junior synonym of *C. semilabris*. This problem remains to be resolved. Either way, neither the Crooked Island nor the Salt Cay species is the Haitian taxon identified as *C. semilabre* by Bartsch, which leaves Barstch's species without a valid name. This new species is described below.

SYSTEMATICS

Family Annulariidae Henderson and Bartsch, 1920

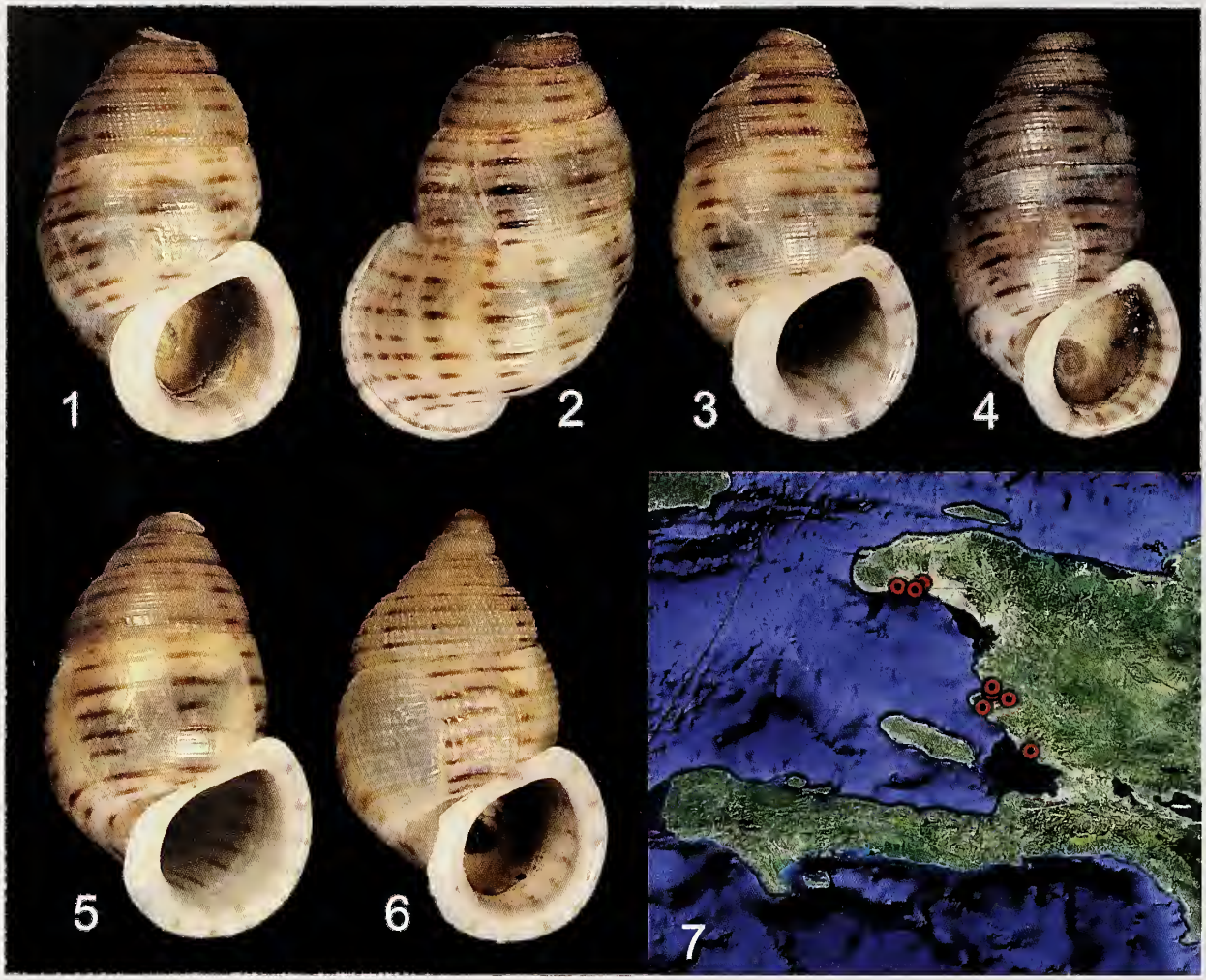
Genus *Chondropoma* Pfeiffer, 1847

Type Species: *Cyclostoma sagra* d'Orbigny, 1842, by subsequent designation of Petit de la Saussaye, 1850.

Chondropoma bellavittatum new species

(Figures 1–7)

Description: Shell thin but solid, opaque, obese. Maximum adult size: 17.6 mm maximum length, including peristome, decollate. Minimum adult size: 12.9 mm maximum length, including peristome, decollate. Shell usually decollated even at juvenile stage. Protoconch of 1.5 minute, smooth, rounded whorls, pale tan, demarcation between protoconch and teleoconch not well-defined. Teleoconch of 4.75 whorls. Primary axial sculpture on final whorl very fine and close-set, but irregular and nearly obsolete except for widely spaced growth stoppage marks. Axial sculpture on earlier teleoconch whorls of very fine, closely spaced, numerous threads (ca. 80/whorl). Spiral sculpture on final whorl (including umbilicus) of ca. 30–35 very fine, very widely spaced, raised threads. Intersections of axial and spiral sculpture forming microscopic raised beads. Suture



Figures 1–7. *Chondropoma bellavittatum* new species. **1–2.** Holotype, UF 33135, 12.9 mm length. **3.** Paratype 1, UF 33135, 15.4 mm length. **4.** Paratype 2, UF 33135, 16.5 mm length. **5.** Paratype 3, UF 33135, 14.2 mm length. **6.** UF 33104, 5 km WNW of Anse-Rouge, Department Artibonite, 12.6 mm length. **7.** Distribution of *Chondropoma bellavittatum* new species. Map Google™ Earth Pro. Image Landsat. ©2105 Google. Data: SIO, NOAA, US Navy, NGA, GEBCO.

strongly indented, almost channeled. Suture smooth to minutely serrate; no sutural tufts present. Aperture teardrop-shaped, lip double. Complete inner lip fused to outer lip, not well-defined. Outer lip expanded, except much narrower facing umbilicus, widest anteriorly, lamellar on umbilical or medial side, smooth on the lateral side, produced into small, wide auricle at posterior border. Outer lip narrowly attached to previous whorl. Umbilicus minute and compressed. Base color grey to white. Patterned with ca. 12 narrow, interrupted, dark brown spiral bands, which cease at growth stoppage marks; length of brown coloration on bands varying from band to band between long streaks and short dashes. Specimens rarely lacking bands. Aperture and lips white, brown bands often continuous across both faces of outer lip but only apparent on lateral side. Operculum paucispiral with fine, granular, calcareous deposit. Radula and anatomy unknown.

Type Material: Holotype, Florida Museum of Natural History (UF) 33135, 12.9 mm length. Paratype 1, UF 33135, 15.4 mm length. Paratype 2, UF 33135, 16.5 mm length. Paratype 3, UF 33135, 14.2 mm length. Paratype 4 UF 33135, 17.5 mm length.

Type Locality: 1 km E of Baie-de-Henne, Department Nord Ouest, Haiti, ca. 19.6611° N, −73.2041° W.

Other Material Examined: Haiti: UF 33135 (60 specimens), 1 km E of Baie-de-Henne, Department Nord Ouest; UF 33104 (88 specimens), 5 km WNW of Anse-Rouge, Department Artibonite; UF 33099 (85 specimens), 60 m, 1 km W of Petit Paradis, Department Artibonite; UF 31992 (49 specimens), 100 m, 3 km SE of Montrois, Department Nord Ouest [not found]; UF 32651 (3 specimens), W side of Etang Bois Neuf, 14 km S of Saint-Marc, Department Artibonite; UF 32722 (38 specimens), 10 km ESE of Saint-Marc, Department Artibonite.

Distribution: Specimens described here are from the region of Baie-de-Henne, Anse-Rouge, and Saint-Marc.

Bartsch (1946) also listed the area of Arcahaie. Based on museum records, this species ranges along the coastal western slopes of the Massif du Nord Ouest and the Chaîne des Matheux on nearly the entire western side of the northern peninsula (Figure 7). This is a fairly wide range for the otherwise narrowly endemic annulariids seen in Hispaniola.

Habitat: Specimens were locally common on limestone ridges in xeric areas with cacti.

Variation in Specimens: The northern populations differ from those in the south in having more obsolete sculpture on the final whorl and having the spiral brown bands continue onto both faces of the outer lip; the outer lip is white in the southern specimens. The two populations are separated by a wide river valley, the Plaine de l'Artibonite, and they may be found to constitute two subspecies when soft tissue for phylogenetic material becomes available.

Comparison with Other Species: The color pattern and overall shell shape are seen in several superficially similar Hispaniolan species, particularly with members of *Sallepoma* Bartsch, 1946. Those species differ in the strong axial sculpture and near lack of spiral sculpture, and in having a pseudolamellate operculum composed of a heavily calcified, raised plate parallel to the cartilaginous base.

Remarks: Of the 323 specimens, both adult and juvenile, only a single individual (an adult) retained a protoconch (Figure 6). Decollation apparently happens before the adult stage is reached. Numerous specimens exhibited a small circular bore hole in the final whorl, presumably made by the predaceous larvae of lampyrid or elaterid (Drilini) beetles.

Etymology: Latin *bellus*, beautiful + L. *vittatus*, decorated with a ribbon. The genus-name root *-poma* is neuter.

ACKNOWLEDGMENTS

The author thanks Gustav Paulay, John Slapcinsky, Amanda Bemis, and Fred Thompson (UF) for access to their invaluable collection and an anonymous reviewer.

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Notice

THE 2016 R. TUCKER ABBOTT VISITING CURATORSHIP

The Bailey-Matthews National Shell Museum is pleased to invite applications for the 2016 R. Tucker Abbott Visiting Curatorship.

The Curatorship, established originally in aceordance with the wishes of the late Dr. R. Tucker Abbott, Founding Direetor of the Shell Museum, is awarded annually to enable malacologists to visit the museum for a period of one week. Abbott Fellows are expected, by performing collection-based research, to assist with the curation of portions of the Museum's collection and to provide one talk for the general public. The Museum collection consists of marine, freshwater, and terrestrial specimens. The majority of the collection lots have been catalogued through a computerized database management system; part of the catalogue is already available for searches online at: www. http://shellmuseum.emc2webs .com/collection/. The R. Tucker Abbott Visiting Curatorship is accompanied by a stipend of $1,500.

Interested malacologists are invited to send a copy of their curriculum vitae, a letter detailing their areas of taxonomic expertise and research objectives, and to provide a tentative subject for their talk. Send materials to:

Dr. José H. Leal, Science Director & Curator
The Bailey-Matthews National Shell Museum
P.O. Box 1580
Sanibel, FL 33957 USA
jleal@shellmuseum.org

Applications for the 2016 Visiting Curatorship should be sent electronically to the above e-mail address no later than May 31, 2016, or postmarked by that date if sent by regular mail. The award will be announced by late June 2016. Questions about the Visiting Curatorship should be sent to the e-mail address above, or by phone at:

(239) 395-2233; fax (239) 395-6706

Errata

In the listing of "New Taxa Proposed in Volume 129" published in *The Nautilus*, volume 129, issue number 4, the Editor neglected to include the following taxa, all proposed by Watters and Fraussen (2015):

NEW TAXA PROPOSED IN VOLUME 129

GASTROPODA

Engina annae Watters, 2015, new species (Buccinidae) 97
Engina lignea Watters, 2015, new species (Buccinidae) 106
Engina permixta Watters, 2015, new species (Buccinidae) 106
Engina williamsae Watters, 2015, new species (Buccinidae) 112

LITERATURE CITED

Watters, G.T. and K. Fraussen. 2015. A revision of the western Atlantic Ocean *Engina* with notes on *Hesperisternia* (Gastropoda: Buccinidae: Pisaniinae). The Nautilus 129: 95–117.

INSTRUCTIONS TO AUTHORS

THE NAUTILUS publishes articles on all aspects of the biology, paleontology, and systematics of mollusks. Manuscripts describing original, unpublished research and review articles will be considered. Brief articles, not exceeding 1000 words, will be published as notes and do not require an abstract. Notices of interest to the malacological community will appear in a notices section.

Manuscripts: Each original manuscript and accompanying illustrations should be submitted to the editor preferably via e-mail or as hardcopy in triplicate.

Text must conform to the dimensions of 8½ × 11-inch paper, double-spaced, and single-column throughout (including literature cited, tables, and figure captions). Authors should follow the general recommendations of *Scientific Style and Format—The CSE Manual for Authors, Editors, and Publishers*, available from the Council of Science Editors at www.councilscienceeditors.org. The first mention of a scientific name in the text should be accompanied by the taxonomic authority, including year. Metric, not English, units are to be used. Geochronologic modifiers should be capitalized only when units are formally recognized: for instance, use Late Cretaceous but early Miocene. Likewise, only modifiers of formally recognized chronostratigraphic units are capitalized: use Lower Jurassic but upper Oligocene.

The sequence of sections should be title page, abstract, introduction, materials and methods, results, discussion, acknowledgments, literature cited, tables, figure captions, figures. The title page should include the title, author's name(s) and address(es). If corresponding author is not the senior author, please indicate. The abstract should summarize in 250 words or less the scope, main results, and conclusions of the article. Abstracts should be followed by a list of additional key words. All references cited in the text must appear in the Literature Cited section and vice-versa. Please follow a recent issue of THE NAUTILUS for bibliographic style, noting that journal titles must be unabbreviated. Information on plates and figures should be cited only if not included within the pagination of cited work. Tables must be numbered and each placed on a separate page. If in doubt, please follow a recent issue of the journal for sequence of sections and other style requirements.

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All line drawings must be in black, clearly detailed, and completely labeled. Abbreviation definitions must be included in the caption. Line drawings must be high resolution files at least 600 dpi (dots per inch) resolution at actual size. Standard digital formats for line drawings include .tif, .bmp, .psd, .eps, and .pdf.

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